

An Assessment of Stormwater Management Practices Using MSMA Manual in Malaysia

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ABSTRACT

In response to the needs for paradigm shift the way the stormwater is managed, the Malaysian government has launched the new Stormwater Management Manual for Malaysia (DID, 2001) incorporating the latest development in stormwater management that is known as “control-at-source” approach. The source-control approach is a relatively new concept in stormwater management practices in Malaysia that refers to “Source Control Systems” indicating any processes which modifies the runoff from an area of land where that modification is close to the source of the flow. The new concept of Stormwater Management in Malaysia is focused on the integration of urban planning and utilization best management practices to achieve the objectives of sustainable drainage systems for urban areas. This new approach utilizes detention/retention, infiltration, conveyance, purification processes as well as delayed flow as suggested in the Manual. As a result, the quality and quantity of the runoff from developing area can be maintained to be the same as predevelopment conditions.

This paper studies the current status of stormwater management practices in Malaysia and to develop an informational for Malaysian Government to update the existing Stormwater Management Manual for Malaysia. The purpose of the project was to provide a comprehensive and assessments of MSMA guidance and its use in Malaysia, based on information provided by key stakeholder. The main findings of the study can be used to develop information, tools, and guidelines for developing effective local stormwater management programs; and to provide up-to-date technical information to engineers, planners, and developers for implementing practical and effective local best management practices and related policies and programs.

In order to more effectively accomplish these goals, a survey was conducted of 3 major key stakeholder groups i.e. developers or contractors, consultants and local authorities to identify the prominent stormwater issues across Malaysia. The survey methodology, results, and conclusions drawn by the research findings are summarized in this paper. The result presented the findings from the first evaluation of MSMA guidance, which establishes the attitudes, perceptions and experiences of a wide range of practitioners and other experts.

Keywords: Urban BMPs, Control-at-source, Sustainable Urban Drainage Systems,

Evaluation, Stormwater Management

1 Introduction

Traditionally, the stormwater management has been practiced to transport runoff as quickly as possible through the drainage system in order to prevent flooding and protect lives and property. Although public health and safety are still the most important goals, other objectives must now be met as well, such as the preservation of water quality and natural habitat. Today, it is necessary to balance both quantity and quality objectives simultaneously. The concept of "integrated approach" to planning and designing of urban stormwater is moving away from the conventional thinking of designing for flooding to balancing the impact of urban drainage on flood control, quality management and amenity. In order to achieve the mentioned objectives, Malaysian Government has launched the Urban Stormwater Management Manual for Malaysia with a new stormwater drainage design standard effectively on January 2001. The underlying designs philosophy of the new 2001 Standard of "source control approach" differs significantly from the 1975 Standard's approach of "rapid discharge of runoff". The success of the implementation of this new approach is not yet known after it was launched in 2001. Therefore, the objective of this study is to evaluate the status of the stormwater management practice in Malaysia such as issues on public awareness, design aspect, cost, maintenance and public acceptance towards the Manual.

The study will focus on a survey of local authorities, developers and consultants in Malaysia regarding their views on several stormwater issues; the development of a non-technical stormwater management for local authorities; and the development of a non-technical public awareness on stormwater

management for decision makers, highlighting and building upon information related to stormwater management.

The initial investigations have shown that cost implications, lack of knowledge of suitable construction details and methods, together with the responsibility for the maintenance are the major impediments to successful Best Management Practices (BMP's) systems construction. This study is to highlight the issue of lack of knowledge of BMP's systems. Consequently, one of the objectives of this study is the acquisition of data or information, which will assist in the preparation of improved guideline/manual for their implementation.

Therefore, it is hope that the findings and information obtained from this study can be used for updating version of Urban Stormwater Management Manual for Malaysia (MSMA) in future. The updated version of MSMA will incorporate the local data and specific local needs to manage the stormwater runoff under tropical climates. The main reason why the MSMA was not been widely adopted in practice is the lack of guidelines and standards. It is hope that the findings from the survey will provide latest information on the stormwater management practices in Malaysia and guidance to improve the lacking in the Manual. This must take account of the full range of issues such as design aspect, cost, benefits, downstream implications and maintenance implications of each system to enable holistic approach to manage the stormwater.

2 The Survey – Questionnaires

The issues and types of problems involving stormwater management and urban runoff do not significantly vary across the hydrologic regions of Malaysia.

One very important goal of this study is to provide up-to-date information about effective stormwater management practices to local technical and non-technical officials such as mayor, local authorities executives, and other related government agencies. This will better enable them to promote public awareness and implement programs in their communities to minimize non point source water pollution and local flood damage. Additionally, this study is carried out to establish the level of awareness of BMPs, to investigate the effectiveness of the information and guidance on the practices, to investigate any misconception regarding BMPs use and performance and to generate information on whether the developer's fears of using BMPs have been realized.

From September 2002 until May 2003, survey questionnaires were sent out to local authorities, consultants and contractors in order to more fully understand the broad range of stormwater management issues which are of greatest concern to these local authorities, consultants and contractors. The data and local perspective obtained from this survey will provide information for better targeting and managing the stormwater runoff locally.

3 Methodology

A major purpose of the survey is to understand not only the present state of stormwater quality and quantity management in Malaysia, but also to assess the degree of institutional understanding of stormwater issues by local decision-makers and stakeholders. Consequently, surveys were sent out to consultants, contractors and local authorities across Malaysia.

The survey were sent out with the aim of generating detailed information about Malaysian stakeholders in MSMA, and their opinion of guidance and reference

materials, specifically: (1) knowledge and understanding; (2) experiences with MSMA; (3) awareness and perceptions of MSMA options; (4) awareness and perceptions of the MSMA Manual. Precise and unambiguous questions were formulated to minimize any potential misunderstanding. The design, administration, processing and analyses of questionnaire results were carried out using MS Excel spreadsheet. The survey questions include questions on stormwater concerns and practices including barriers to effective control, quality and quantity concerns, and program needs. This survey questionnaire was distributed to selected local authorities (e.g. DID), consultants and contractors with instructions for the survey to be completed by the local individual who deals most directly with technical issues regarding stormwater management.

4 Interpretation of Survey Results

4.1 Questionnaire responses

The survey results of stakeholders either publics, local authority representatives, consultants, contractors and developers are discussed in this paper. A total of 300 surveys were sent either by e-mail or post, and only 60 were returned, equating to a response rate of 20%. The 60 survey questionnaires, which were returned, did not require the respondents to disclose their identities for the purpose of anonymity. However, responses has showed that 44% from local Authority, 30% public, 21% consultants, 4% academicians and only 2% are contractors as shown in Figure 1. The distribution of the respondent based on profession is shown in Figure 2 with 54% respondents were an engineer, 30% were director or managers, 2% were planners and the remaining from other professions.

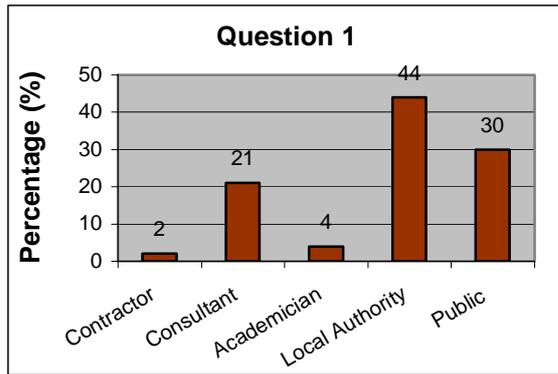


Figure 1 Percentage of respondents based on the nature of the company.

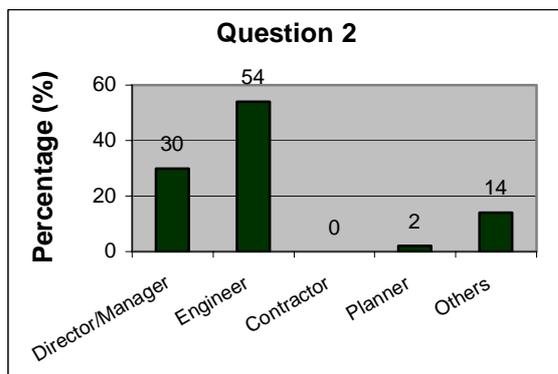


Figure 2 Percentage of respondents based on the profession.

4.2 Awareness and expertise of the sample population

Most respondents (about 79%) to the questionnaire were aware of the existing of the new, 'Urban Stormwater Management Manual for Malaysia' (DID, 2001) which was designed to replace the 'Urban Stormwater Drainage Procedure' (1975) effectively on the 1st January 2001. The survey result shows that 21% respondents were still not aware of the new Urban Stormwater Management Manual for Malaysia (MSMA) as shown in Figure 3. These findings demand the urgent need for the Government to exercise more publicity and awareness campaign to alert public of the existing of new Manual and Guideline for Stormwater Management in Malaysia. The main obstacles that preventing the success of modern storm runoff control measures, whether by structural or non-

structural measures is the lacking of community participation. The success of the new concept of stormwater management depending both on community participation and on a change in technical thinking, so as to incorporate storm drainage into the complete urban and environmental concept also known as holistic approach of stormwater management.

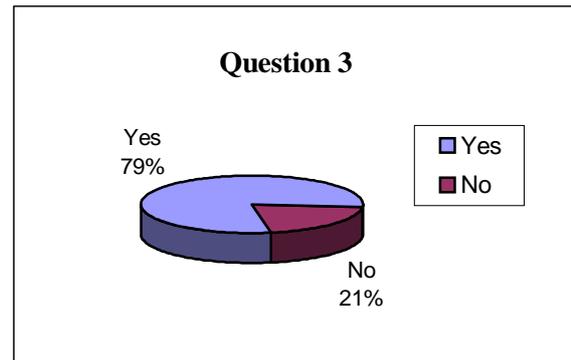


Figure 3 The Respondents Awareness on the new Urban Stormwater Management Manual for Malaysia (DID, 2001).

Figure 4 shows that 53% of the respondents have more than five years experience in designing and construction of stormwater drainage. Only 47% of the respondents have less than five years experience in designing and construction of stormwater management. This survey indicates that more than 50% of the respondents have experiences more than 5 years. The more experiences and knowledge in designing and construction of stormwater drainage will ensure the successful of the design and construction of stormwater management facilities.

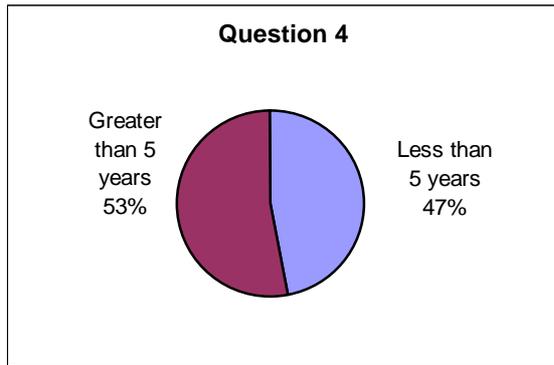


Figure 4 The respondent years of experience in designing and construction of stormwater drainage.

As shown in Figure 5, 86% of the respondents have stated that they are willing to implement the stormwater facilities in their area as suggested in new Manual. Only 5% are not willing to implement the stormwater facilities and 8% stated no response to the question. The results demonstrate that the respondents are willing to change their mindset and have paradigm shift for a better stormwater management practices to control flooding and pollution problems.

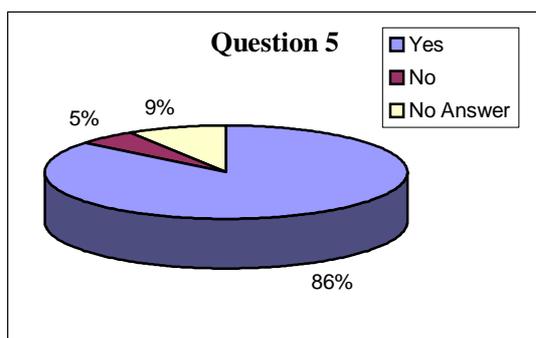


Figure 5 The respondent opinions on the willingness to implement the stormwater facilities as listed in MSMA.

The new MSMA manual required the engineers to use software to assist in design, analysis and simulation of the stormwater facilities. The results of the survey in Figure 6 show that 25% of the respondents have used software for the

design of stormwater drainage. However, 12% of the respondents have not used any software for the design of stormwater drainage. Surprisingly, 63% of the respondents stated no answer whether the respondents were using the software in their design process. Amongst the software used by the respondents were XP-SWMM, MIDUSS98, ISIS and MOUSE. The survey shows that most of the engineers in Malaysia are still not exposed and competent using software for the design, analysis and simulation of the stormwater facilities. Therefore, it is a good opportunities for stormwater software supplier to market their software in Malaysia.

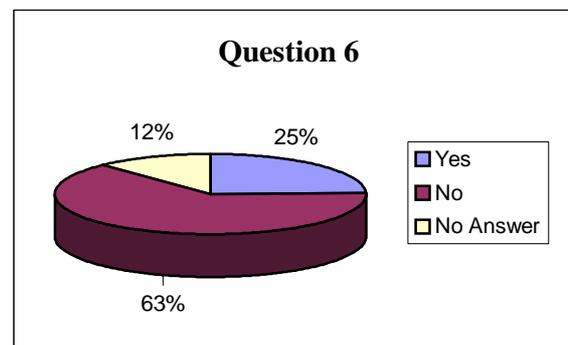


Figure 6 The usage of software for the design of stormwater drainage.

The respondents were also asked to choose which house to invest either House A with Open Concrete Drainage System and House B with the Ecological Drainage System. Figure 7 shows that almost 89% respondents have chosen House B with Ecological Drainage Systems and 9% have chosen House A with open concrete drain. Only 2% did not answer this question. The majority of respondents were ready to have changes and willing to pay for better facilities. However, the question is how much they are willing to pay the increment of the total cost. Figure 8 shows that 41.5% respondents that have chosen House B are not willing to pay any extra cost. However, 39% of the respondents are willing to pay the increment of less

than 5% of total cost and only 12.2% respondents are willing to pay the increment between 5% to 20% of total cost. As expected, only 7.3% of the respondents who have chosen house B are willing to pay increment more than 20% of the total construction cost.

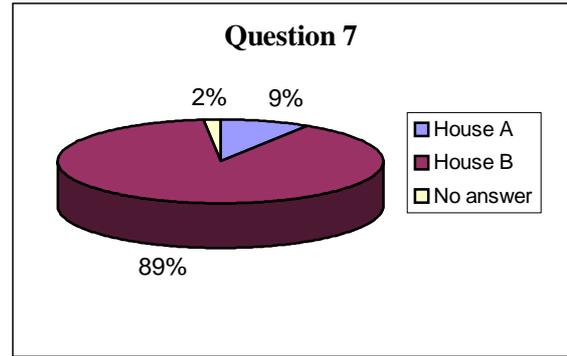


Figure 7 The result for survey Question 7: “If you’re given a choice, which house would you like to invest on? (Please tick).



House A with Open Concrete Drainage System



House B with Ecological Drainage System

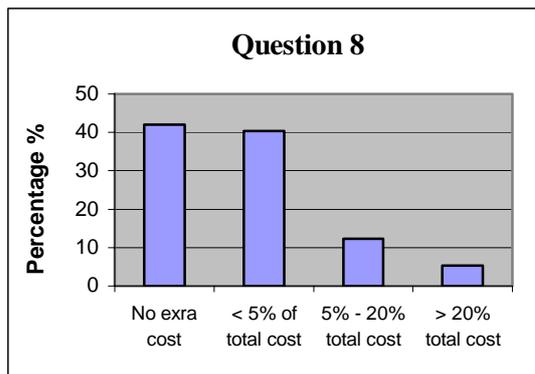


Figure 8 The respondent willingness to pay the extra cost incurred in the construction of the new drainage.

and roads is widely perceived as a problem by respondents, with 87% citing that they have flooding problems in their communities. This trend shows a common problem across the country and very little geographic variation (Figure 9). 87% of surveyed respondents noted flooding problems in their communities (Figure 9) due to inadequate drainage systems such as drains, culverts, manholes etc. The Local authorities need to retrofit the existing drainage systems in order to reduce the local flooding problems.

4.3 Flooding Problems

Local flooding of public, commercial, and industrial space; residences; and streets

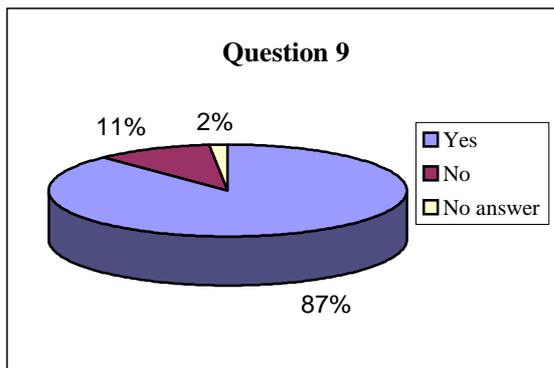


Figure 9 The result for survey Question 9: “Do you have local flooding problems of public, commercial, and industrial space, residences, and streets and roads due to inadequate drainage systems (drains, culverts, manholes, detention ponds, etc.)?”.

4.4 Water Quality Issues

The survey shows that water pollution is a significant issue in communities across Malaysia. Sixty-five percent (65%) of respondents indicated that in terms of public health, aquatic environment, or citizen complaints, stream pollution is of "some" to "great" concern in their communities (Figure 10). Meanwhile, 26% respondents show little concern to the stream pollution and 5% respondents showed no concern at all. This implies some Malaysians are not concerned with the environmental protection and the impact of pollution to the environment in the existing waterways. Therefore, the Government needs to increase the public awareness on the environmental protection amongst the Malaysian citizen starting from primary schools. Besides that the electronic and printing media can also play their role in educating the Malaysian citizen about the environmental protection and sustainable development. Active cooperation with the media, newspapers, television, radio, magazines, etc. to provide information to the public can be effective way to increase the awareness. In addition, for the environmental approach to be successful, a change of technical culture is required through training

(capacity building at all levels, for district engineers and urban planners) and environmental education for the public.

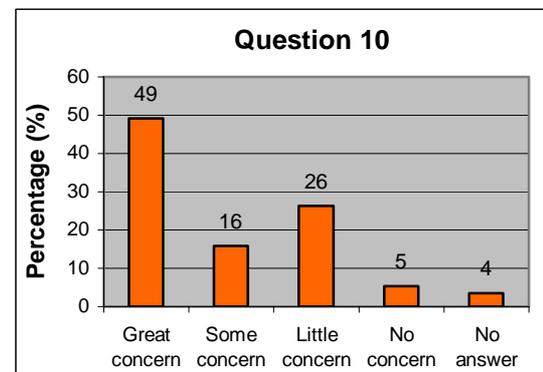


Figure 10 The result for survey Question 10: “In terms of public health, aquatic environment, or citizen complaints, how much concern is given to stream pollution (pesticides, herbicides, fertilizers, sediment, motor oil, etc.) in your community?”.

The most common sources of water quality problems cited by respondents were construction sediment (40%), litter/illegal dumping (32%), leaking sewers (25%), eroding streambanks (23%), runoff from paved areas (21%), and threat to drinking water supply (19%) (Figure 11). Threats to water supplies and groundwater, and runoff from agricultural and lawns were rarely cited (Figure 11). Surprisingly, 42% respondents stated that the rivers, or lakes in the respondents community were posted by local or state health authorities as being unsafe or unfit for recreation or human contact due to water pollution as shown in Figure 12. This finding can be summarized as follows:

- 65% of all surveyed respondents expressed "some" to "great" concern about stream pollution in their communities (Figure 10)
- The most common major water quality problems were indicated to be construction sediment (40%),

litter/illegal dumping (32%), leaking sewers (25%), eroding streambanks (23%), runoff from paved areas (21%), and threat to drinking water supply (19%) (Figure 11).

- 42% of all surveyed respondents cited "posted" rivers in their communities is not safe and fit for recreation or human contact due to water pollution (Figure 12)

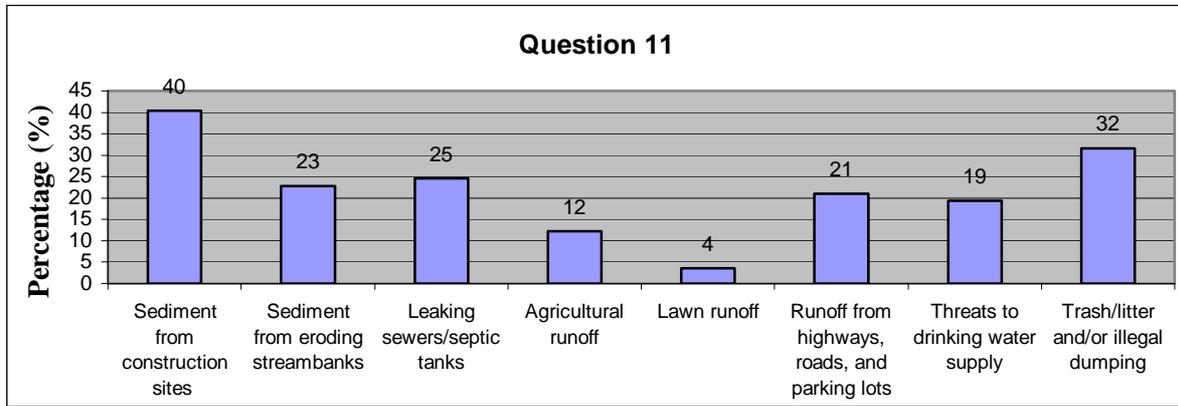


Figure 11 The result for survey Question 11: “Which of the following are your major water quality problems?.

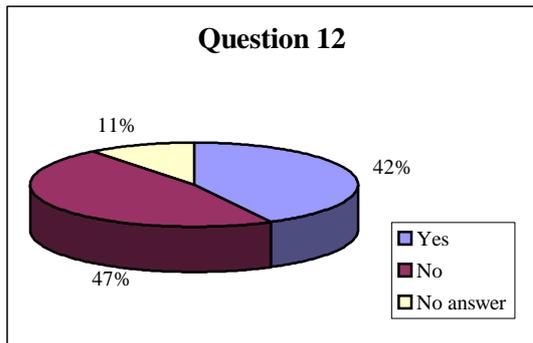


Figure 12 The result for survey Question 12: “Are any of the rivers, or lakes in your community posted by local or state health authorities as being unsafe or unfit for recreation or human contact due to water pollution?

4.5 Stormwater Management Tools

In the majority of Malaysia communities, 36% respondents shown in Figure 13 stated that response to complaint and litigation appear to be the primary mechanism used to prevent and control stormwater pollution. State and federal regulations were cited by respondents in 31% of communities (Figure 13). Local land use controls and ordinances were cited by 29% of communities (Figure 13). About 31% of respondents indicated that their communities have public awareness programs (Figure 13). These trends show very little geographic variation throughout the country.

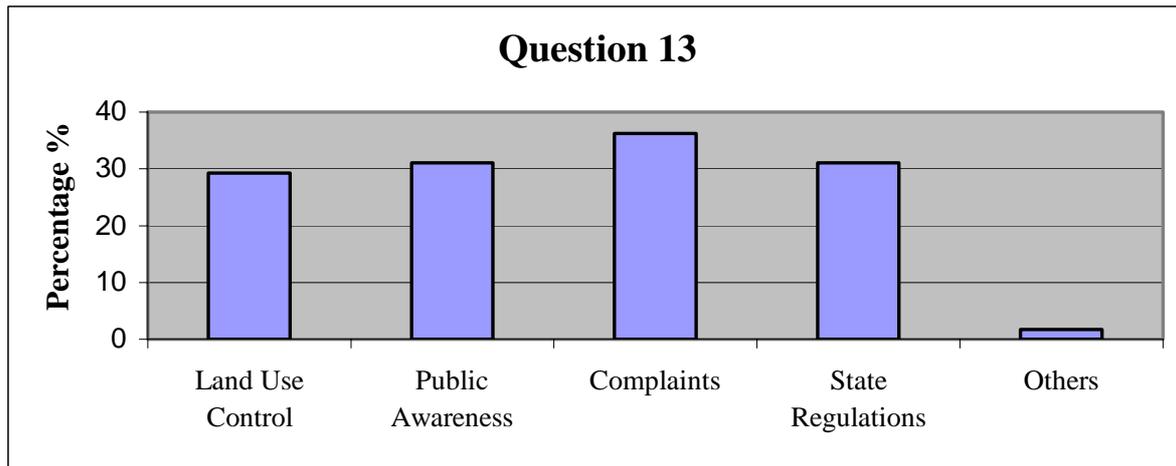


Figure 13 The respondent opinions on methods that are being used in the community to prevent or control stormwater pollution.

The new manual (MSMA) requires the engineers to become more innovative and creative in their design by using different techniques as suggested in the new Manual MSMA based on the site conditions and suitability of the soils. The aim is to control the stormwater at source with the target to reduce the generated runoff from post development to pre-development level. The result from survey (Figure 15) has shown that 28% of respondents have experience using detention pond, 19% respondents have experience using On-site Detention (OSD) and 14% have experience using perforated pipe systems and porous pavements. Only 11% have experience using infiltration facilities such as grass swale and infiltration trench. The survey has also shown that only 5% of the respondents have experiences using wetland as stormwater techniques in any new development project.

Amongst the stormwater management facilities, wetland is not popular choice in any new development in Malaysia due to lack of knowledge and design standard and procedures. The data used in designing the wetland in MSMA is solely based on overseas data especially from Australia (DID, 2001). The results on the

effectiveness of wetland and pond systems in reduction of stormwater pollution show them to be highly varied. This is not unexpected, as these systems are highly complex systems with significant interaction between its ecology, soil chemistry, and hydrodynamic characteristics. Current design guidelines for wetland and pond systems in MSMA as stormwater treatment facilities are still very much in their infancy and based primarily on performance curves from overseas.

At the beginning, it is expected that developers particularly oppose “soft-engineered” systems i.e. retention ponds, wetlands and swales. Perhaps developers perceive that these systems take more time and effort to develop, and that they cost more in terms of land acquisition and maintenance. However, open and above ground systems should be easier to maintain than below ground systems, and the engineering of swales is comparatively simple and cost effective (Lloyd et. al, 2001). Moreover, these soft-engineered systems allow the relevant local authorities to rapidly identify and rectify pollution incidents.

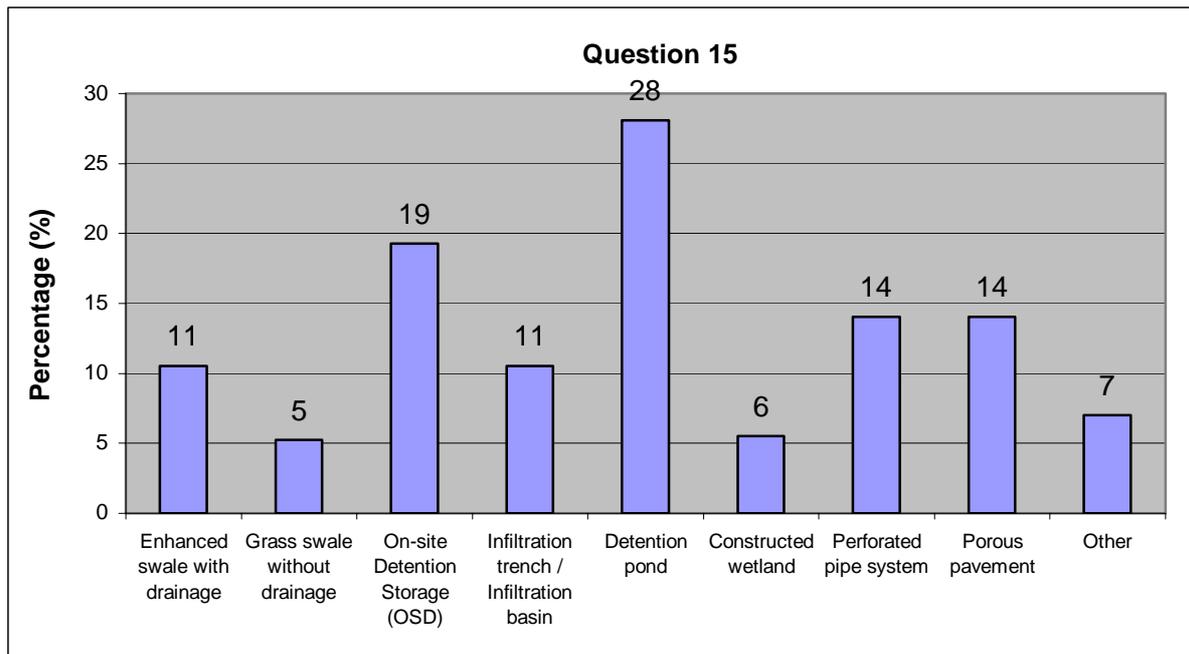


Figure 15 The respondent experience using the stormwater management facilities as recommended in Stormwater Management Manual for Malaysia (MASMA).

When asked whom the respondent would consult to find out more about stormwater problems, the respondents most often cited the Malaysian Department of Drainage and Irrigation (46%), followed by the Local authorities (19%) (Figure 16). The Drainage and Irrigation Department and Local authorities play important roles to give more information and technical support regarding the stormwater management problem quantity and quality. Overall observation from the analysis on questions related to the methods to prevent the stormwater pollution (Question 13) and experience on using stormwater facilities e.g. detention pond (Question 15) are as follows:

- 36% of communities use response to complaints or litigation to control

stormwater pollution (Figure 13)

- 31% of communities use state and federal regulations and public awareness programs to control stormwater pollution (Figure 13)
- 29% of communities use local land use controls and ordinances to control stormwater pollution (Figure 13)
- 28% of respondents have experience using detention pond and 19% have experience using On-site Detention (OSD) (Figure 15)
- 11% of respondents have experience using infiltration facilities such as grass swale and infiltration trench and less than 5% of respondents have experience using constructed wetlands (Figure 15).

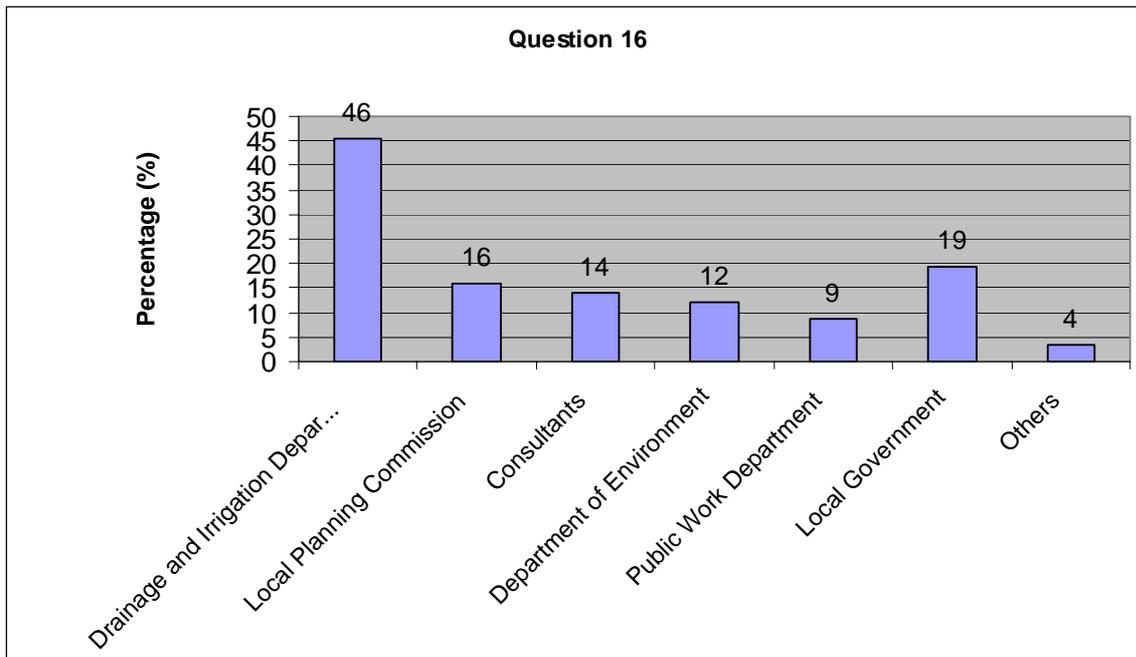


Figure 16 The respondents opinion on groups or agencies to consult when to find out more about stormwater quality/quantity problems.

4.6 Barriers to Stormwater Management

Concerns over education/lack of information regarding stormwater management, funding and enforcement are the three most significant barriers to managing stormwater in local Malaysia communities. Education/lack of information regarding stormwater management concerns were indicated by 39% of respondents, funding were indicated by 35% of respondents and enforcement were indicated by 33% of respondents (Figure 14). The less important barriers appear to be limited staff (26%) and lack of regulations (19%) (Figure 14). Generally, these trends show little geographic variation across the country.

- 39% of respondents cited education/lack of information regarding stormwater management concerns as a barrier to stormwater management in their community (Figure 14)
- 35% of respondents cited funding as a barrier to stormwater management in their community (Figure 14).

In order to increase the knowledge of the public about the stormwater management the Government must actively provide a variety of information by means of local council public relation activities. Effective methods here would include public advertising, pamphlets, newsletters, videos, symbol marks, character design, display of actual stormwater management facilities e.g. infiltration trench, etc. Active cooperation with media, newspapers, television, radio, magazines, etc. to provide information is also effective. The Local Authorities can hold public meetings, road show, demonstrations and events to alert the public of new concept of stormwater management. The motivation and awareness of people is essential for wider acceptance of stormwater management concept to ensure the successful of Urban Stormwater Management Manual for Malaysia (MSMA) in Malaysia.

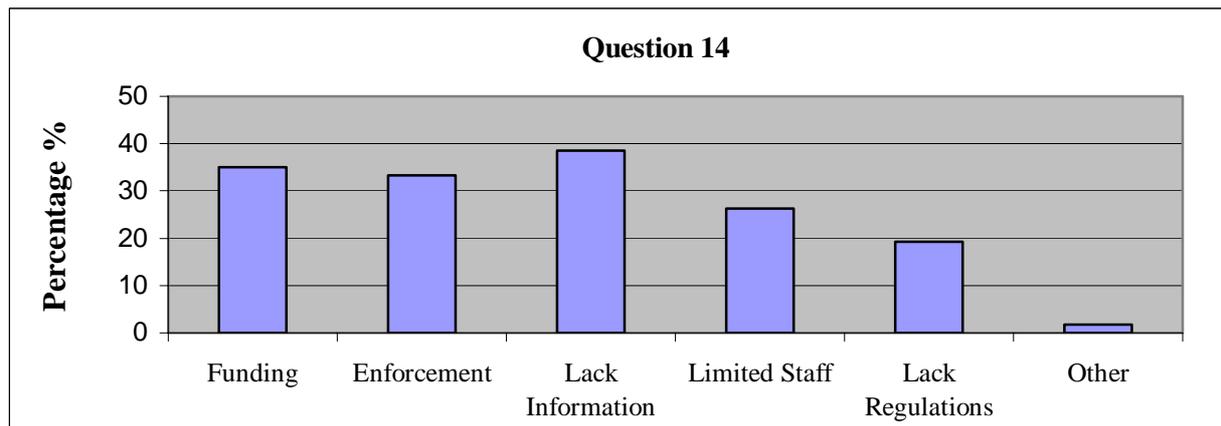


Figure 14 The result for survey Question 14: “What barriers may exist for stormwater management in your community?.”

Funding is one of the barriers for the implementation of stormwater management in the community. In order to encourage people to install stormwater facilities in their community is to give them subsidy. The Government should appropriate the construction cost of infiltration facilities in its budget to provide subsidy for local authorities to actively encourage the construction of such facilities. Using this subsidy, the local authorities can install such facilities in public facilities and can also offer the subsidy to residents who install the said facilities. This subsidy can motivate the people and accelerate the acceptance of stormwater management concept in Malaysia.

Many respondents felt that a lack of information/clarity about who was responsible for adoption and maintenance of MSMA facilities had been the main

deterrent to their use. Land take was also found to be a significant deterrent. This indicates that whilst designer/developer could identify potential improvements to guidance but the most deterrent is the worry of adoption and maintenance of the facilities. Another deterrent is the procedure of obtaining approval from relevant authorities.

5 Discussions

Based on a review of the storm water management survey and discussions with the relevant parties, four major issues as shown in Figure 17 have been identified as the most important to address in advancing the concept of MSMA. These are: the regulatory framework; assessment and costing; technology and design; and marketing and acceptance.

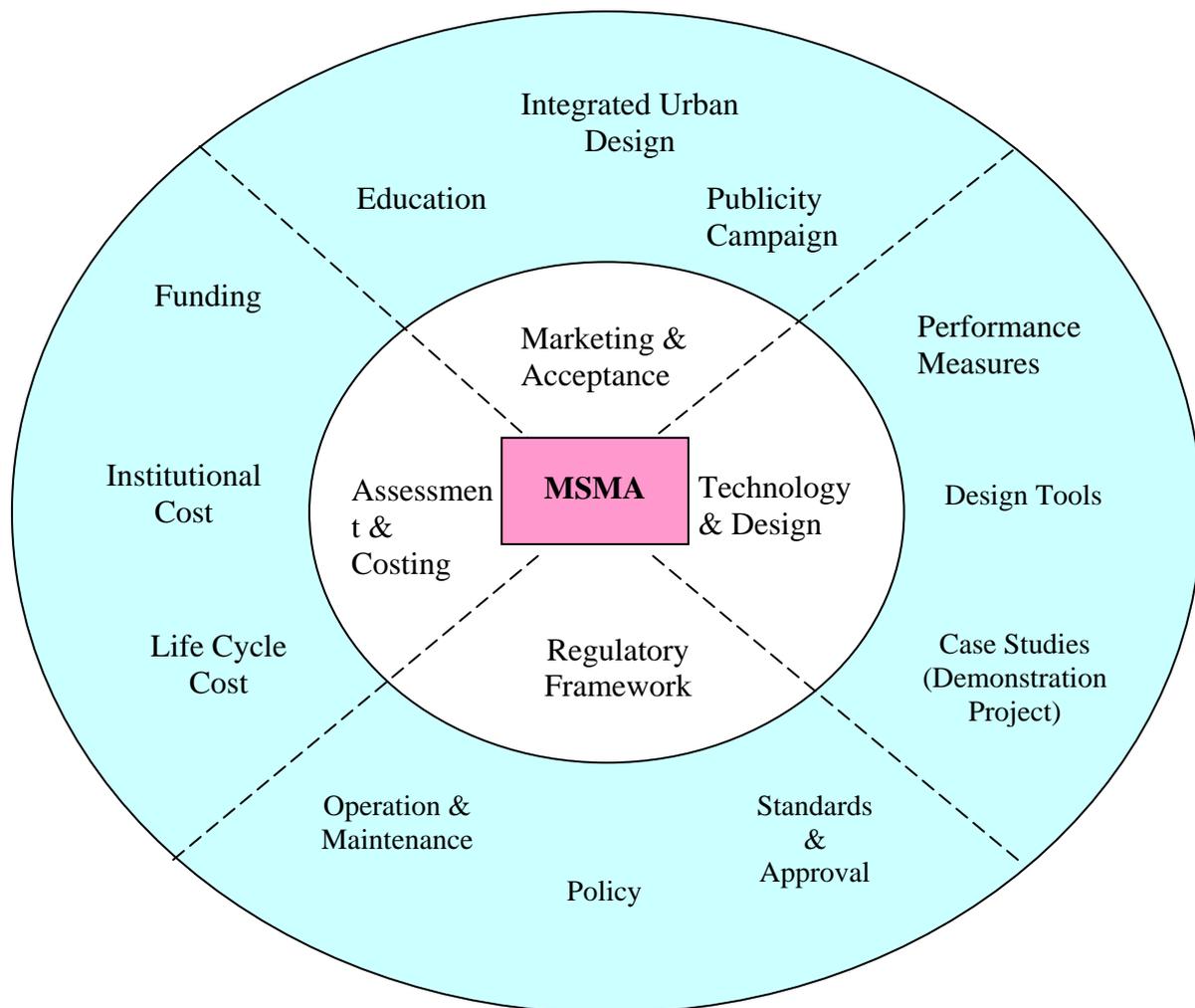


Figure 17 Key components to successfully integrating Environmentally-friendly drainage systems (MSMA) into urban development projects.

Currently, in Malaysia the responsibilities for water supply, stormwater and wastewater management are separated within or between organizations. This fragmentation of responsibilities creates difficulties in getting different organisational sectors to work together in a positive manner across administrative boundaries. Therefore, good stormwater management requires a collaborative approach between state and local authorities to create an effective operating environment for MSMA practices. Policy, codes and guidelines need to be amended to facilitate this. Implementation of this policy will require standards and approval procedures to be redrafted to

incorporate MSMA planning and treatment measures. A key issue is the skills and capability of engineers from DID to approve new project based on control at source approach. To overcome this, the government should implement education and training programs for key stakeholders and provide guidelines for assessment and approval standards to address these types of issues.

Local authorities are generally responsible for approving development applications and specifying the development standards to be met. These standards are often based on rigid engineering conventions and do not allow for an innovative or integrated approach to

water management. It was realized that the skill and culture of local authorities and water authorities was not generally sufficient to support the changes required to assess and implement projects involving MSMA. This creates a reluctance to accept the perceived risks involved in approving and implementing MSMA projects. Awareness and education of senior and middle management is required to promote MSMA within local authorities, water authorities, consultants and contractors. The series of training workshops and road shows were organised by DID and many more series of training should be conducted in future to raise workplace skills of employees to a level suitable to meet MSMA assessment and approval needs.

Another issues need to be addressed is the technology and design aspect of the MSMA. Two key issues in the design and construction stages of water management scheme that can influence the long-term effectiveness of the system are the use of multi-disciplinary design teams and the protection of BMPs during construction activities. It is now required for any government project to submit the Environmental Management Plan (EMP) for the construction site to be submitted with any development application. In addition, the developer needs to submit the Erosion and Sediment Control Plan (ESCP) with consideration of the construction sequence of the various MSMA elements to protect them from sediment loads. This ESCP plan should be submitted together with drainage submission report to DID for approval.

At the moment, there is limited quantitative data on the long-term performance of MSMA technology in Malaysia. A lack of information on operation and maintenance practices for BMPs leads to concerns within local authorities about the long-term viability and costs associated with water management schemes. The awareness of

operation and maintenance practices by operations and maintenance staff is critical to guarantee the success of MSMA projects. Some possible strategies to clearly define operation and maintenance procedures include providing staff education and training, developing inspection routines, preparing checklists with clear identifiable indicators of inadequate system performance and preparing provisional action plans to promote prompt action to rectify problems as they arise. These activities aim to ensure that staff clearly understands the objectives of MSMA and are familiar with the maintenance programs associated with MSMA.

Finally, community education about MSMA has many issues to address; from empowering the community with a sense of ownership of their local stormwater assets and to informing the community about future changes to water resource management. Community education will help to reduce public concerns generated by the unfamiliar aspects of stormwater management concept. Ultimately, individuals should be sufficiently informed so that the community can accept the new concept drainage systems using source control approach as recommended in the New Stormwater Management Manual for Malaysia (MSMA).

6 Suggested Improvements to Guidance

The following list of potential improvements to guidance is derived from suggestions made by respondents within their completed questionnaires, or during workshops and interviews (Table 1). They are not presented in any particular order, and for the sake of brevity, several comments have led to be omitted. These suggestions do however represent the most frequently recorded comments:

Table 1 Suggested Improvements to Guidance.

General MSMA Guidance	MSMA Design Manual
1. Provide information on the cost of the MSMA facilities;	1.Reduce the cost of the manual and provide greater access to guidance (e.g. via internet)
2. Make available information on Malaysian case studies;	2. Revise the selection tool in the manual;
3. Provide detail information on the maintenance procedures and responsible agency;	3.Include more case studies and practical examples;
4. Provide on-line access on the MSMA database for the benefits of the users.	4. Specify types of MSMA that are acceptable in different scenarios;
5. Provide guidance about the integration of MSMA and grey water/water reuse;	5. Provide more information on the design of inlets and outlets;
6. Address inconsistencies in advice provided by stakeholders;	6.Provide more design examples for infiltration basin and infiltration trench;
7. Produce and regularly update a summary of available guidance;	7.Provide examples for different runoff estimation hydrograph method (e.g. Non-linear reservoir, Kinematic Wave method and Rational Method Hydrograph method);
8. Regularly obtain feedback on the use of the manual and other guidance on MSMA;	8.Provide examples for hydrologic or hydraulic routing method (e.g. Muskingum method);
9. Regularly review the quality of guidance, in light of increasing MSMA experience; and	9.Improve explanations of hydraulic calculations in the example (e.g. errors in calculation)
10.Arrange training events for all stakeholders, and short seminars to raise awareness of MSMA (e.g. Short courses by IEM, CPD BEM program)	10. Include more information about system performance (especially in-ground systems);
11. Provide low cost guidance material, to facilitate greater access;	11. Include more details on the ecological aspects of MSMA (e.g. habitat enhancement);
12. Produce a “landscaping specification” for MSMA	12. Improve the quality of particular drawings to illustrate the stormwater treatment train and its use and;
13. Provide keyfacts or simple brochure for every stormwater facilities as a supplement of the MSMA manual.	13. Arrange training seminars at which free copies of the manual are distributed.

6 Conclusions

Perceptions of stormwater issues are almost common throughout Malaysia and not much difference in views between the respondents with different background. The results of the surveys illustrate these findings, but also make it evident that urban stormwater management presents a challenge in communities across Malaysia. Some findings are as follows:

- Flooding of various types is perceived to be a widespread problem in Malaysian communities. Immediate

action should be taken by Government to reduce the flooding problems using curative and preventive approach. The preventive approach includes the new stormwater management concept “control at source” as introduced in MSMA Manual (DID, 2001).

- The most significant water quality problems in Malaysia communities are perceived to be construction sediment, litter/illegal dumping, and sediment from eroding streambanks. In response to the construction sediment problem, the MSMA has suggested

Erosion and Sediment Control Plan as part of the drainage submission for approval from DID. Erosion and Sediment Control Plan should recommend the Best Management Practices facilities such as silt traps, sediment basins and etc. to control erosion and reduce sedimentation in the rivers. Surface water quality is of more concern than groundwater quality.

- The most common community goals in managing stormwater are to control damage from runoff, to control erosion/sediment to protect property, to protect health and safety, and to meet federal or state regulations. The new MSMA manual is targeting to achieve the community goals as mentioned above and it's moving away from the conventional thinking of designing for flooding to balancing the impact of urban drainage on flood control, quality management and amenity.
- Many technical representatives believe that maintaining stormwater runoff quantity and quality at pre-development conditions are practical goals. The positive thinking and willingness to have paradigm shift from conventional "rapid disposal" approach to new concept of MSMA manual can ensure the successful of the stormwater program.
- The most commonly used stormwater management tools in Malaysia communities are response to complaints, public awareness programs and state/federal regulations. The present level of public awareness on the causes of flash flood problems, erosion and siltation is generally low. The public needs to be educated about their role in reducing this occurrence. The Government can do so through educational system and through the printing and electronic media.
- The most significant barriers to stormwater management in Malaysia communities are concerns over

education/lack of information regarding stormwater management and funding. The Government needs to increase funding for flood mitigation works by treating the drainage works as part of basic infrastructures in terms of cost. In addition, the Government should encourage fundamental research data on the processes involved in floods, erosion and siltation by making available research funding and resources for collaborative research works by local universities and government agencies.

- The development of a widely available, Malaysian-oriented stormwater management planning workshop and updated manual supported with local data would be useful.

As a conclusion, the barriers hindering the wider adoption of MSMA has been identified from the study. Amongst the barriers are perception of increased costs, lack of design guidance, lack of design experience, lack of available modeling tools, operation and management uncertainty and issues on adoption and ownership. This information is very important in order to tackle the barriers so that the successful implementation of the new concept in MSMA can be ensured.

Effective new concept of Stormwater Management Manual (MSMA) is not easy to achieve and requires an innovative approach. Innovation, by definition, involves risk taking, and risk can occasionally lead to failure. However, it can also lead to success. Both success and failure are important components of research experience to be shared in the updated version of MSMA in next five years. The key point of promoting the stormwater management concept is the creation of systems to persuade these people that stormwater management concept has a positive value, it involves no major problems, and can even be beneficial. Now is indeed a fitting time for

stormwater management concept to be moved towards the stage of practical application and widespread adoption of the technology as suggested in MSMA throughout Malaysia. Overall, the outputs of the study gives a useful insight into the status of stormwater management practices and effectiveness in Malaysia of MSMA manual that will help with the development and delivery of new updated version of MSMA manual.

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